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ON THE PRESENCE OF BARIUM IN THE ASH AND EXTRACT OF CERTAIN KANSAS WEEDS.

By E. H. S. BAILEY and L. E. SAYRE, University of Kansas, Lawrence.

SOME time during the last year, at the suggestion of Dr. S. J. Crumbine, we made an analysis of ash of certain weeds growing in this state. It was thought that there might be some relation between the composition of the ash of these weeds and the acute disease, anterio poliomyelitis (infantile paralysis), which has been prevalent in Kansas as well as throughout other states within the last two or three years. As there was one case reported in Douglas county, one of us (Bailey), in company with F. Agrelius, on October 13, visited the locality, which is about twelve miles southwest of Lawrence, and collected samples of the weeds growing in the pastures where the cows were feeding. The milk of these cows had been used by the family. This was, however, not a typical case of infantile paralysis, as the family had not lived in this locality very long, having come from Osage county. The weeds growing in the pasture were of the ordinary variety found in upland pastures. As there was a swale with a small stream running through the pasture, some of the plants were more or less aquatic. The genera and species of the plants were identified by Mr. Agrelius.

For the chemical analysis, a convenient amount was ashed and special tests were made, after a few preliminaries, for the amount of ash, insoluble residue (iron, alumina, phosphoric acid, calcium oxide, magnesium oxide, and especially barium oxide).

The following weeds were found growing in the Moss pasture:

Goldenrod—Solidago altissima L.
Horsemint—Monarda fistulosa L.
False indigo—Amorpha fruticosa L.
Ditch stonecrop—Penthorum sedoides L.
Spanish needles—Bidens involucrata (Nutt.) Britton.
Goldenrod—Solidago rigida L.
Cottonwood leaves—Populus deltoides Marsh.
Three-seeded mercury—Acalypha virginica L.
Aster—Aster Lævis L.
        Aster dumosus L.
Sour dock—Rumex altissimus Wood.
False indigo—Baptisia leucantha T. & G.
        Aplopappus ciliatus (Nutt.) D. C.
False gromwell—Onosmodium occidentale Mack.

Sedge—Cyperus esculentus L. (?)
Willow leaves—Salix longifolia Muhl. (?)
Osage orange—Maclura pomifera (Raf.) Schneider.
Annual ragweed—Ambrosia trifida L.
Green foxtail—Setaria viridis (L.) Beauv.
Fetid marigold—Dysodia papposa (Vent.) Hitch.
Dandelion—Taraxacum officinale Weber.
Coral berry—Symphoricarpos orbiculatus Moench.
Thistle—Circium discolor (Muhl.) Spreng.
Ironweed—Vernonia baldwinii Torr.
*Mare's tail—Erigeron canadensis L.
Vervain—Verbena stricta Vent.
*Agrimony—Agrimonia parviflora Ait. (?)
Triple-awned grass—Aristida oligantha Mx.
Nimble Will grass—Muhlenborgia schreberi J. F. Gmel.
Horse nettle—Solanum carolinense L.
*Croton weed—Croton capitatus Mx.
Mullein—Verbascum thapsus L.
Lobelia—Lobelia syphilitica L.
Mallow—Sida spinosa L.
*Goldenrod—Solidago tenuifolia Pursh.
Dogwood—Cornus asperifolia Ms.
Mountain mint—Pyenanthemum flexuosum (Walt.) B. S. P.
Frog fruit—Lippia lancelolata Mx.
White clover—Trifolium repens L.
Blue grass—Poa pratensis L.
Crab grass—Digitaria sanguinalis L. Scop.
*Elder—Sambucus canadensis L.

Some of these were abundant, others were found only in small quantities. Those marked * were collected in sufficient quantities so that the ash could be examined. Others, which were found afterwards to contain barium salts, were collected in the vicinity of Lawrence in sufficient quantity for analysis. The plants collected locally were as follows:

Indigo—Baptisia leucantha T. & G.
Hedge—Maclura pomifera (Raf.) Schneider.
Ragweed—Ambrosia artemisiae folia L.
Horseweed—Ambrosia trifida L.
Ironweed—Vernonia baldwinii Torr.
Erigeron—Canadensis L.
Yellow dock—Rumex crispus L.
Wild lettuce—Sonchus asper (L.) Hill.
Corn—(white field).

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* Large samples taken.

In table I is given an analysis for the ash, and the amount of barium and manganese found.

TABLE I.

No.	Common name.	Per cent ash. Ave. $\frac{2}{2}$.	Per cent Ba., as $BaSO_4$, in ash.	Per cent Mn. in ash.
3790	Goldenrod	2.97	None.	.34
3791	Agrimony	2.55	.25–.27	.1137
3792	Mare's tail	4.05	None.	.122
3793	Croton weed	4.70	Trace.	.122
3794	Aplopappus ciliatus	14.84	.44	.044
3795	Sambucus (Moss)	1.69	.45	.128
3799	Ragweed	4.36	.18	.16
3800	Horseweed	7.55	None.	.079
3850	Ironweed	4.08	None.	.083
3851	Baptisia	2.31	None.	.096
3852	Osage orange	9.96	None.	.032
3853	Yellow dock	2.76	None.	.019
3854	Wild lettuce	2.77	None.	.075
3730	Oxytropis lamberti (Pursh)	15.89	.27	.091
3878	Sambucus (local)	1.36	.23	Undetermined.
3880	Equisetum hyemal (horse tail)	6.01	None.	.058

The soil of the Moss pasture was also examined, using the hydrochloric acid extract. In one sample no barium was obtained, and in another a trace. A little manganese was found to be present. The water of the small stream running through the pasture was also examined and found to contain no barium, but 0.0042 gms. per liter of manganese.

An examination was also made (table II) to determine the amount of insoluble residue (iron, alumina and phosphoric acid, calcium oxide and magnesium oxide) in the ash.

TABLE II.

No.	Per cent insoluble residue.	Per cent $Fe_2O_3+Al_2O_3+P_2O_5$.	Per cent CaO.	Per cent MgO.
3790	7.13	.15.32	9.70	2.78
3791	23.65	22.77	17.15	2.11
3792	4.67	18.88	20.29	4.92
3793	26.34	4.30	45.95	6.26
3794	10.64	23.33	18.46	5.22
3795	3.36	14.37	21.99	6.20
3799	4.56	18.94	20.27	6.49
3800	3.41	22.20	17.65	3.48
3850	8.08	18.91	30.34	4.69
3851	1.96	19.65	41.00	5.53
3852	9.73	8.37	46.79	6.07
3853	15.71	9.14	6.75	6.67
3854	14.31	9.77	14.70	6.76
3730	65.22	13.11	13.02	1.85
3878	3.11	27.72	24.02	5.66
3880	65.97	6.25	12.37	1.5
3865	63.08	6.51	8.63	3.66
3855 (soil)	73.31	13.21	.44	.70
3798 (water)*	.0299	*.0183	*.1392	*.0456

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* Grams per liter.

It will be noticed that the common plants containing barium are *Sambucus* (the elder), ragweed, *Aplopappus ciliatus*, *Oxytropis lamberti* (Pursh), and agrimony.

In regard to the occurrence of barium and its effect, attention is called to the article by Albert C. Crawford on "Barium and Cause of the Loco-weed Disease," Bureau of Plant Industry, Bulletin No. 129, and more recent articles on the same subject. Here are many quotations as to the effect of barium on the system, and also feeding experiments of barium salts on animals in the laboratory. Among the other symptoms mentioned, paralysis is noted. In the Bulletin of the Agricultural Experiment Station, University of Nebraska, part I, 1905, is a report on poisoning of cattle by certain weeds, some of which produce some of the symptoms of paralysis.

It is a well-known fact that cattle, during August and September, when there is often lack of rain and the forage is scarce, will eat such plants as ragweed and the green sprouts of *Sambucus*. There was no opportunity to feed cows on such fodder exclusively, to determine whether the milk secreted would contain barium and manganese. Such experiments would be of interest.

From the pharmaceutical laboratory the results in connection with this report are as follows:

So far as the relation of barium constituent in connection with the disease called "locoism" is concerned, the experiments in the pharmaceutical laboratory, under the immediate supervision of Mr. James T. B. Bowles, indicate that while barium may be a very large factor in producing the disease, there is an indication that there is another principle which the *Astragalus* contains that acts as a poison to guinea pigs. For example, 400 grammes of the finely divided *Astragalus* was macerated with Prollius fluid and perfectly exhausted by the fluid. This was evaporated to dryness and the residue purified with 90-per-cent alcohol. The alcoholic residue was disolved in water, made slightly alkaline, and shaken out with chloroform, and afterward with ether. The ethereal solutions were evaporated to dryness, purified with 95-per-cent alcohol, and again evaporated to dryness. This residue was dissolved in diluted hydrochloric acid. Two cc. of this solution was injected intraperitoneally into a 375-gram guinea pig. The pig first had the nervous twitching of its head, followed with rapid respiration; dullness came on, and then spasms at intervals, which threw the pig into convulsions. The pig finally died in convulsions forty minutes after having been injected with the solution. *Post-mortem* showed that the stomach was quite inflated; the intestines, liver, heart and spleen were normal. The effect seemed to be upon the nervous system.

In experimental work upon the subjoined list of weeds, the idea in the pharmaceutical laboratory was to ascertain whether the barium, if present, would be imparted to a digestive fluid or would be rendered soluble in an artificial gastric fluid. The weeds were ground very finely; 250-gram samples were used. One portion was macerated with water in the cold, while another was boiled for eight or nine hours after macerating. The samples were then digested with artificial gastric fluid. In making the gastric fluid double the amount of pepsin was used as prescribed by the United States Pharmacopœia in the pepsin test. Each sample was digested for two and one-half hours at body temperature. Barium was found only in four samples of the weeds, which will be indicated in the table below. The method used for determining the barium was that used by Crawford, of the Bureau of Animal Industry. The solutions were concentrated and acidified with hydrochloric acid and then precipitated by means of sulphuric acid. The precipitate was collected and weighed as barium sulphate.

In testing the manganese content the persulphate method was used, and manganese was found in the digestive fluid, as indicated.

		Barium, per cent per gm.	Manganese, per cent.
3790	Solidago tenuifolia	....	0.21
3791	Agrimony parviflora	0.21	....
3792	Erigeron canadensis	....	....
3793	Croton capitatus	....	0.06
3794	Aplopappus ciliatus	0.36	....
3795	Sambucus canadensis	0.37	....
3799	Ambrosia artemisiæfolia	....	0.10
3800	Ambrosia trifida	....	....
3850	Vernonia baldwinii Tarr	....	0.06
3851	Baptisia	....	0.07
3852	Osage orange	....	0.25
3853	Rumex crispus	....	....
3854	Sonchus asper	....	....
3865	White field corn	....	....
....	Equisetum hyemale	....	....
....	*Oxythropis lamberti (Pursh)	0.26	....

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* Meade county, near Meade, Kan.